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In the emergency department, the diameter of the inferior vena cava and aorta with ultrasonography in upper gi bleeding

Ultrasonography in upper gi bleeding

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Abstract
Aim: It was aimed to to investigate the use of USG imaging of the inferior vena cava (vci) and aortic diameter in predicting hospitalization in patients diagnosed with upper gi bleeding.
Material And Methods: Forty-five patients over the age of 18 with upper gi bleeding who applied to the emergency department between 01/02/2019 and 01/10/2019, and 45 volunteers without hypovolemia as the control group were included in the study. VCI and aortic diameters of the patients were recorded prospectively using USG.
Results: While the mean age in the patient group was 67±19 years, it was calculated as 74±9 years for the control group. The mean values of VCI expiratory, inspiratory diameters and VCI collapse index in the control group and patient group were respectively 18.47±2.5 mm, 15.2±2.4 mm and 0.18±0.06; 15.56±3.6 mm, 13.2±3 mm and 0.15-0.12. The mean values of aortic suprarenal and infrarenal diameters in the control group and patient group were respectively 24.3±2.2 mm and 21.7±2.3 mm; 19.0±3.6 mm, 17.0±3.4 mm. When all these parameters were compared with the control group, statistically significantly lower values were recorded in the patient group ($p<0.001$).
Discussion: In our study, vci diameter, aortic diameter, and vci collapsibility index values were lower in patients with upper gi bleeding, and although they can be used as an aid in the diagnosis of the disease in the emergency department, these low values were not found to be associated with the hospitalization or discharge decision of the patients.

Keywords
Gastrointestinal Bleeding, VCI Diameter, Aortic Diameter, USG

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Introduction

Gastrointestinal system (GIS) bleeding has critical importance in emergency department admissions due to high mortality, morbidity, and hospitalization costs. Upper gastrointestinal bleeding is the most common in GI bleeding. These hemorrhages originate from the proximal part of the ligament of Treitz and the mortality rate varies between 5-10%. Despite advances in diagnosis and treatment methods, the desired improvement in mortality rates has not been achieved. Early diagnosis of hypovolemia in cases of bleeding may help to prevent at least some of these deaths [1-3].

Ultrasonography (USG) in the emergency department has become increasingly widespread, especially since it can be performed as a bedside examination and can be repeated and it does not cause additional financial loss [4-6].

Inferior vena cava (VCI) diameter is related to intravascular volume rather than systolic blood pressure and is used to determine fluid deficit. Changes in the total body fluid volume are directly related to changes in the diameter of the vascular system [7]. Evaluation of the VCI diameter with USG shows intravascular status and provides a prediction in decision for fluid resuscitation. In cases where the intravascular volume decreases, the percentage of VCI collapse increases [8, 9].

Since there is no gold standard scale and/or examination to determine the need for transfusion and duration of hospitalization and discharge of patients who apply to the emergency department with upper GI bleeding, imaging with USG can be used as a fast and non-invasive method. Therefore, in this study it was aimed to investigate the effects of ultrasonographic imaging of the inferior vena cava and aortic diameter on hospitalization and discharge of patients who applied to the emergency department with upper gastrointestinal bleeding.

Material and Methods

VCI and aortic diameters were evaluated with USG and laboratory and clinical data of patients over 18 years of age with upper gastrointestinal system bleeding who applied to the Emergency Department Training and Research Hospital between 01/02/2019 and 01/10/2019, were recorded prospectively.

This study was designed as a single-center and prospective clinical study, ethical approval was obtained from the local Ethics Committee with the decision dated 06.02.2019 and numbered 28.

Approximately 24000 patients apply monthly to the Emergency Department Training and Research Hospital, and about 120 of them undergo endoscopy with the suspicion of GI bleeding. Patient flow diagram is shown in Figure 1. To compare this patient group, a control group consisting of 45 volunteers without hypovolemia and according to our inclusion criteria was added to the study. Information was provided both in writing and verbally. Patients whose informed consent was obtained were assured that they could withdraw from the study at any stage of the study, with or without justification. Inclusion criteria for the study were as follows: patients over 18 years of age, with upper GI bleeding diagnosed by endoscopy who accepted to participate in the study after reading the informed consent form. The exclusion criteria were as follows: patients younger than 18 years of age, no gastrointestinal bleeding visible at endoscopy, those who were referred or who came as a primary patient and received fluid therapy, pregnant women, congestive heart failure, chronic kidney failure, liver cirrhosis, using inotropic drugs, having varicose veins, cor pulmonale and malignancy, and those who refused to participate in the study after reading the informed consent form.

The pre-and post-endoscopy conditions of the patients were determined using Glasgow-Blatchford and Forrest scores. VCI and aortic diameter measurements of patients with upper GI bleeding were evaluated in the transverse plane with a 3.5 MHz convex probe with an ultrasonography device (Mindray brand UMT - 200 model, Hamburg, Germany) in our emergency department. USG was performed each time by the same experienced practitioner who has a certificate in the use of bedside ultrasonography. VCI diameter measurements were obtained during inspiration and expiration in M mode in a cross-sectional view at the level of the left renal vein or 2 cm caudal to the hepatic vein entrance, with the patients in the supine position, with the probe angled from the subcostal region to the right shoulder in subxiphoid view. The inferior vena cava collapsibility index (VCI-CI) was calculated by recording the diameters in the inspiration and expiration. This index was calculated by dividing the difference between VCI expiratory diameter and the VCI inspiratory diameter by VCI expiratory diameter [(VCI expiratory diameter – VCI inspiratory diameter) / expiratory diameter] x 100. Aortic diameter measurements were recorded in the transversal cross-sectional view from the suprarenal and infrarenal regions in the area from the subcostal region to the iliac bifurcation with the patient in the supine position. All these data were recorded for each patient. Finally, value of VCI and aortic diameter measurements in patients with upper GI bleeding was investigated in determining the hospitalization location of the patients.

Statistical analysis

Statistical analyses of the study data were performed with SPSS 16.0 for the Windows software package. The normality of data was tested using the Kolmogorov-Smirnov test. The normally distributed variables were reported as mean±standard deviation and non-normally distributed ones as median (min-max). Three independent groups were compared using the Kruskal-Wallis test for variables without normal distribution and One-way ANOVA with post hoc Bonferroni test for normally distributed variables. Receiver Operating Characteristics (ROC)

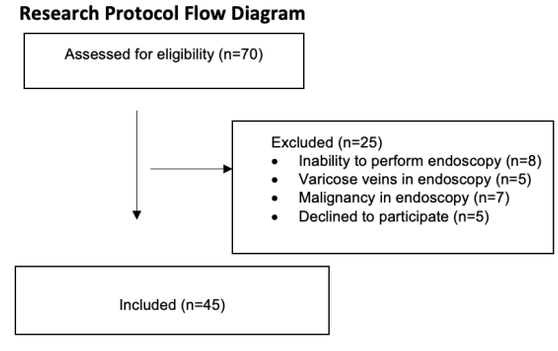

Figure 1. Research Protocol Flow Diagram

curves with area under the curve, sensitivity, and specificity values were drawn to determine the predictive ability of oxidative stress parameters for disease prediction. Statistical significance was set at p<0.05.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

Age (p=0.101) and gender (p=0.506) distributions were similar between the patient and control groups (Table 1).

The mean values of VCI expiratory diameter, inspiratory diameter and VCI-CI in the control group were found as 18.47 mm (min: 13.2- max: 25.5), 15.2 mm (min: 8.6- max: 22.0) and 0.18 (min: 0.05- max: 0.35). In the patient group, the mean VCI expiratory diameter was 15.56 mm (min: 10.3- max: 28.0), the mean VCI inspiratory diameter was 13.2 mm (min: 3.3- max: 20.0), and VCI-CI mean value was determined as 0.15 (min: 0.05- max: 0.73). A statistically significant difference was found between the control-patient group (p<0.001). VCI inspiratory diameter, VCI expiratory diameter, and VCI-CI were statistically significantly lower in the patient group compared to the control group. The mean values of aortic suprarenal diameter and infrarenal diameter of the control group were respectively 24.3 mm (min: 20.0- max: 28.0) and 21.7 mm (min: 18.0- max: 26.0). In the patient group, the mean aortic suprarenal diameter was 19.0 mm (min: 12.0- max: 28.0), and the mean aortic infrarenal diameter was 17.0 mm (min: 10- max: 25.0). A statistically significant difference was found between the control and patient groups (p<0.001). Aortic suprarenal diameter and aortic infrarenal diameter were statistically significantly lower in the patient group compared to the control group (Table 2).

When the clinical outcome of the patient group was correlated with VCI and aortic diameter together with the VCI-CI, no significant difference was found in terms of discharge, admission to the ward, and admission to the intensive care unit (p>0.05) (Table 3).

Table 1. Demographic data of groups

		Control	Patient
Gender*	Male	n=28 (%62.2)	n=31 (%68.9)
	Female	n=17 (%37.8)	n=14 (%31.1)
Age**	Min	65	19
	Max	92	103
	Mean	74	67

Min: minimum, Max: maximum; * Chi-square test; p=0.506; ** Mann-Whitney-U test; IQR; p=0,101

Discussion

Upper GI bleeding is one of the common gastrointestinal emergencies that can cause morbidity and mortality with a rate of 3-10% [10, 11]. Examining the effects of predisposing factors causing bleeding and etiological factors on morbidity and mortality may lead to changes in the treatment approaches to be applied to these patients [12, 13]. For this reason, in this study, we investigated the effects of imaging VCI and aortic diameter by ultrasonography on hospitalization and discharge.

Within the scope of our study, 90 volunteers, 45 controls and 45 patients, were evaluated. As a result, while the mean age of the control group was 74, the mean age of the patient group was 67. No statistically significant difference was found when the groups were compared with each other (p>0.05). However, the mean age was 65 in the study by Stanley et al., which was published in 2016 [14], and the mean age was calculated as 63 in the study by Zhong et al. [15]. Similar to these studies, when we evaluated the patient group within itself, it was observed to be compatible with the literature.

In the literature, it has been determined that upper GI bleeding is seen approximately 2 times more in men than in women [16]. In the study by Robertson et al. [17], 65.6% of the cases were male patients. In our study, 68.9% of the cases were male and 31.1% were female. The fact that most of our patients were

Table 2. VCI, aortic diameter and VCI-CI evaluation between control/patient groups

	Control					Patient					P*
	Mean	SD	Median	Min.	Max.	Mean	SD	Median	Min.	Max.	
VCI expiratory diameter (mm)*	18,47	2,5	18,3	13,2	25,5	15,56	3,6	15,1	10,3	28	<0,001
VCI inspiratory diameter (mm)*	15,2	2,4	15,2	8,6	22	13,2	3	13	3,3	20	<0,001
VCI-CI*	0,18	0,06	0,17	0,05	0,35	0,15	0,12	0,13	0,05	0,73	<0,001
Aortic suprarenal diameter (mm)**	24,3	2,2	24,1	20	28	19	3,6	19	12	28	<0,001
Aortic infrarenal diameter (mm)**	21,7	2,3	22	18	26	17	3,4	17	10	25	<0,001

*Mann- Whitney-U test; IQR; Independent Samples-t test; %95 CI p<0,001; ** Independent Samples-t test; %95 CI p<0,001; SD=standard deviation, Min.=minimum, max.=maximum; VCI-CI= Inferior vena cava collapsibility index

Table 3. Clinical Outcomes of VCI, Aortic diameter and VCI-CI

	Discharged					Admission to the ward					Admission to the intensive care unit				
	Median	Mean	Min.	Max.	SD	Median	Mean	Min.	Max.	SD	Median	Mean	Min.	Max.	SD
VCI expiratory diameter (mm)	15,9	15,8	13,1	18,9	2,2	14,6	15,8	10,3	28	4,2	15,3	14,7	11,7	19,3	2,4
VCI inspiratory diameter (mm)	13	13,7	11,8	17	2	13,3	13,2	3,3	20	3,4	12,3	12,7	10,8	17,3	2,1
Aortic suprarenal diameter (mm)**	19	19	16	22	1,9	19	19,6	13	28	3,5	18	17,8	12	26	4,1
Aortic infrarenal diameter (mm)**	17	17,5	15	20	1,8	17,2	17,5	12	25	3,1	17	16,1	10,6	25	4,4
VCI-CI	0,11	0,13	0,06	0,21	0,1	0,12	0,15	0,05	0,73	0,1	0,15	0,14	0,06	0,21	0,1

Bonferroni test, One Way ANOVA and post-hoc test. Others: Kruskal-Wallis P>0.05; SD=standard deviation, Min.=minimum, max.=maximum; VCI-CI= Inferior vena cava collapsibility index

male is compatible with the literature.

In our study, mean values of VCI expiratory diameter and inspiratory diameter in the control group were found to be 18.47 mm and 15.2 mm, respectively. In the patient group, the mean VCI expiratory diameter was 15.56 mm, mean VCI inspiratory diameter was 13.2 mm. In the study by Akıllı et al. [18] in which hemorrhagic shock patients were examined (trauma, GI bleeding, hemoptysis), VCI ant-post (expiration-inspirium) diameters were found to be lower in the patient group than in the control group. In our study, similar to this study, VCI inspirium and VCI expiratory diameters were found to be significantly lower in the patient group compared to the control group.

The mean values of the aortic suprarenal diameter and infrarenal diameter of the control group were 24.3 mm and 21.7 mm, respectively. In the patient group, the mean aortic suprarenal diameter was 19.0 mm and the mean aortic infrarenal diameter was 17.0 mm. In a study in our country in 2002 in which the diameters of the abdominal aorta were classified according to age and gender, the mean suprarenal and infrarenal values were found to be 20.6 ± 4.7 mm and 17.1 ± 4 mm in women in 55-69 age group, while this rate was 20,6 ± 3.9 mm and 17.6 ± 6.2 mm, respectively, in men [19]. These values are similar to the diameter measurements in our study. Since we could not find a clinical study that we encountered in the literature review that compared the control and patient groups of aortic diameter measurements with each other, the database on this subject was also searched in terms of animal studies. As a result, in an animal study, which was conducted on pigs in 2010 by Jonker et al. [20] a decrease in aortic diameter was observed with blood loss. In parallel with this study, when we compared the control and patient groups in our study, a statistically significant decrease in aortic diameter was found in patients with upper GI bleeding.

In the study by Kaya et al. [21] in 2013 in which they evaluated patients with acute pulmonary embolism by echocardiography, VCI-CI values were statistically lower in the patient group when the control and patient groups were compared with each other (c: 0.62, p: 0.36). Similar to this study, the IVC index value of the patient group was found to be significantly lower in our study (c:0.18, p:0.15). Although the VCI-CI values were similarly decreased, the numerical difference between the values in the patient group (PE: 0.36- upper GI bleeding: 0.15) may limit the normal increase in venous return in case of pulmonary embolism, so the index value could be determined higher. Although the VCI-CI values were similarly decreased, there was a numerical difference between the values in the patient group (PE: 0.36-upper GI bleeding: 0.15); In the case of pulmonary embolism, the index value may have been determined higher, since the normal increase in venous return may be restricted. However, since this index is calculated with the formula [(VCI expiratory diameter – VCI inspiratory diameter) / expiratory diameter] x 100, it may vary due to the difference between the diameters and the distribution of the control and patient groups included in the study.

Limitations

Since our hospital is a 3rd level research hospital and there are usually no empty beds in gastroenterology services, some of the high-risk patients who had to be hospitalized were followed up and treated in the emergency department and discharged. In addition, patients referred to us from nearby 2nd level hospitals mostly showed comorbidity, which may have affected the homogeneous patient distribution. Although our study was designed as a prospective clinical study, the number of cases was limited due to its single-center design. Since the mortality and morbidity rates of the patients included in the study within the inclusion criteria were low, statistical analysis could not be performed on this issue. For this reason, the effect of upper GI bleeding on mortality and morbidity could not be examined. In the future, new multicenter prospective studies can be conducted by considering data such as length of hospital stay, patient cost, emergency surgical procedure, or interventional radiology intervention, which we did not evaluate in our study and therefore cannot comment on its safety and efficacy.

Conclusion

In our study, VCI diameter, aortic diameter, and VCI-CI values were measured and evaluated in patients with upper GI bleeding. As a result of these evaluations, VCI diameter, aortic diameter, and VCI-CI values were found to be significantly lower in patients with upper GI bleeding. Measurement of VCI and aortic diameter with USG and determination of VCI-CI can be used as an aid in the diagnosis of the disease in the emergency department. However, this decrease in values has not been found to affect the decision to discharge or hospitalize patients. Further multicenter clinical studies with larger numbers of patients are needed on this issue.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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